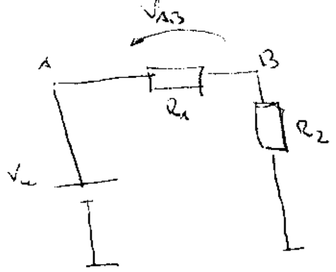
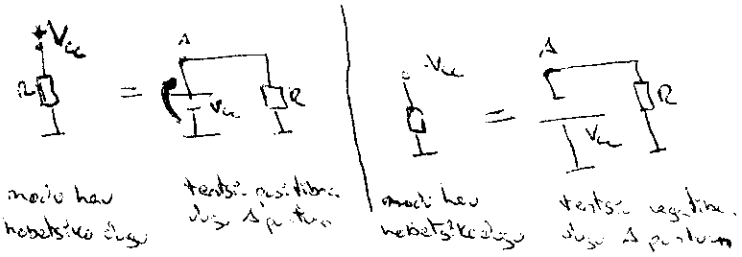


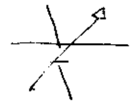
$V_{AB} = V_A - V_B$

- Zirkituak zubiagi ez ... erabiltzen da hainbat kable neurtu behar ez izateko.

* Lehenengo erpinetik gertuen puntuan dago ...
Bigarren erpinetik gertuen aldean dago ...

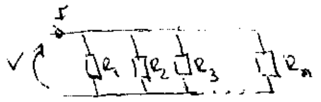
→ Bateriak





ERRESISTENTZIEN ELKARKETA

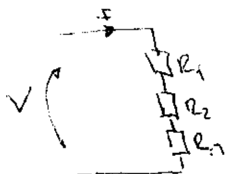
→ Elkarketa paraleloan → erresistentzien terminalak elkarri konektatuta daude



Sinplifikatzeko, erresistentzia baliokidea erabiliko dugu. R_b.

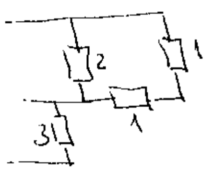
$$\frac{1}{R_b} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n}$$

→ Elkarketa seriean →



$$R_b = R_1 + R_2 + R_3 + \dots + R_n$$

Adibidez



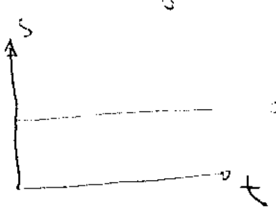
$1+1=2$

$\frac{1}{2}+\frac{1}{2}=1$

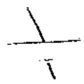
$1+3=\boxed{4}$

SEINALEAK

→ Seinale jarraia/zuzena → beren norantza aldatzen ez duen seinale elektrikoa.



= Konstantea

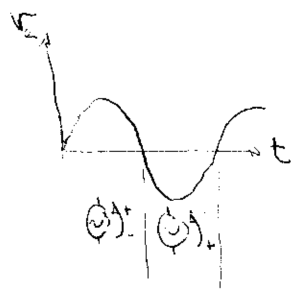


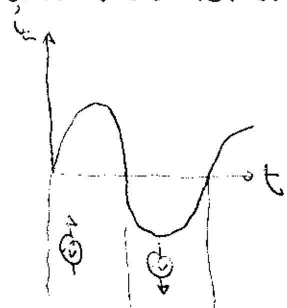
Bateria batek, adibidez, seinale konstantea ematen du.

s = [I, V, P]

= pultsatzailea

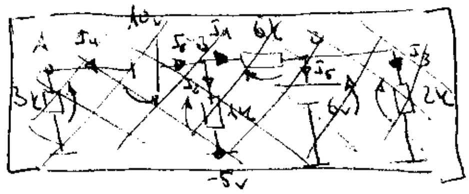
→ Seinale alternoa → beren norantza aldatzen duen seinale elektrikoa

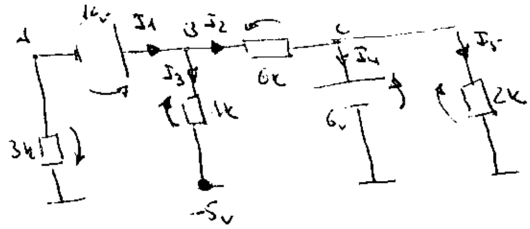




= Sinusoidala

EA · I - 004





B → $I_1 - I_2 - I_3 = 0$

C → $I_2 - I_4 - I_5 = 0$

$3I_1 - 10 + 1I_3 + (-5) = 0$

$3I_1 - 10 - 6I_2 - 6 = 0$

$6 - 2I_5 = 0$

$I_1 = 3'48$ mA

$I_2 = -1'074$ mA

$I_3 = 4'55$ mA

$I_4 = -4'074$ mA

$I_5 = 3$ mA

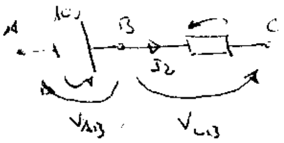
V_A? V_B? V_C?

$V_A = -3 \cdot I_1 = -3 \cdot 3'48 = -10'44$ V

$V_B \to 1I_3 - 5 = 1 \cdot 4'55 - 5 = -0'45$ V

$V_C \to 2I_5 = 6$ V

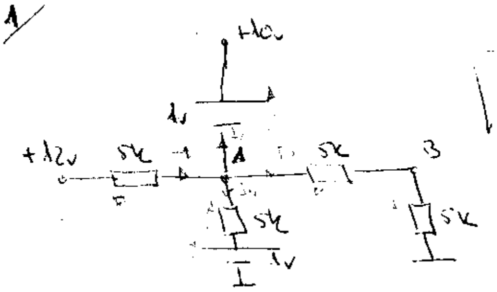
V_{AB}? V_{CB}?



$V_{AB} = -10_v = V_A - V_B = -10'44 - (-0'44) = -10$ V

$V_{CB} = -6I_2 = -6(-1'074)$ $6'44$ V $= V_C - V_B = 6 - (-0'44) = 6'44$ V

1/



$I_1 = I_2 + I_3 + I_4$

$10 \cdot 1 - 5I_4 - 1 = 0$

$10 \cdot 1 - 5I_3 - 5I_3 = 0$

$10 \cdot 1 + 5I_1 - 12 = 0$

$I_4 = 8/5$

$I_3 = 9/10$

$I_1 = 3/5$

$V_A = 9$ V

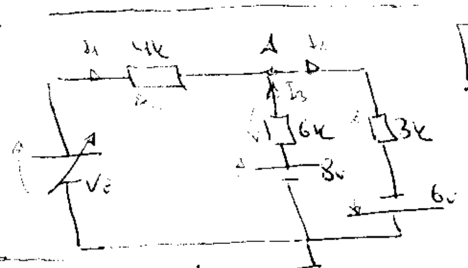
$V_B = 4'5$ V

$I_2 = I_1 - I_3 - I_4 = \frac{3}{5} - \frac{9}{10} - \frac{8}{5} = \frac{6 - 9 - 16}{10} = \frac{-19}{10}$

$V_A \begin{cases} 5I_3 + 5I_3 = \frac{9}{2} + \frac{9}{2} = 9 \text{ V} \\ -5I_1 + 12 = 9 \text{ V} \\ 5I_4 + 1 = 8 + 1 = 9 \text{ V} \end{cases}$

$V_B \begin{cases} 5I_3 = \frac{9}{2} = 4'5 \text{ V} \\ -5I_3 - 5I_1 + 12 = 4'5 \text{ V} \\ -5I_3 + 5I_4 + 1 = -\frac{9}{2} + 8 + 1 = 4'5 \text{ V} \end{cases}$

2/



$V_A = 0'\widehat{3}V_c - 0'88$

$3I_2 - 6 = 3\left(\frac{46}{27} + \frac{V_c}{9}\right) - 6 = -0'8 + 0'\widehat{3}V_c$

$-6I_3 + 8 = -6\left(\frac{46}{27} - \frac{V_c}{18}\right) + 8 = -0'8 + 0'\widehat{3}V_c$

$-4I_1 + V_c = -4\left(\frac{6}{27} + \frac{V_c}{6}\right) + V_c = -0'8 + 0'\widehat{3}V_c$

$\begin{cases} I_1 + I_3 = I_2 \\ V_c - 4I_1 + 6I_3 - 8 = 0 \\ -3I_2 + 6 + 8 - 6I_3 = 0 \end{cases}$

$-3I_1 - 3I_3 + 14 - 6I_3 = 14 - 3I_1 - 9I_3$

$I_1 = \frac{14 - 9I_3}{3} = \frac{14}{3} - 3I_3$

$V_c - 4I_1 + 6I_3 - 8 = 14 - 3I_1 - 9I_3$

$V_c + 15I_3 = 22 + I_1$

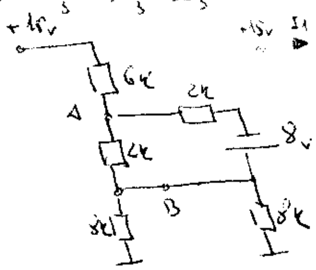
$V_c + 15I_3 = 22 + \frac{14}{3} - 3I_3$

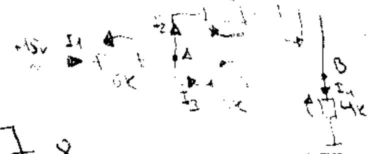
$I_3 = \frac{80}{54} - \frac{V_c}{18} = \frac{40}{27} - \frac{V_c}{18}$

$I_1 = \frac{14}{3} - 3I_3$ $\quad I_1 = \frac{14}{3} - 3\left(\frac{40}{27} - \frac{V_c}{18}\right) = \frac{126 - 120}{27} + \frac{V_c}{6} = \frac{6}{27} + \frac{V_c}{6}$

$I_2 = I_1 + I_3 = \frac{6}{27} + \frac{40}{27} + \frac{V_c}{6} - \frac{V_c}{18} = \frac{46}{27} + \frac{2V_c}{18} = \frac{46}{27} + \frac{V_c}{9}$

3/





$I_1 = I_2 + I_3$

$I_4 = I_2 + I_3$

$I_1 = I_4$

$I_2 = 4 - \frac{25}{22} = \frac{63}{22}$

$I_1 = I_4 = \frac{63}{22} - \frac{25}{22} = \frac{38}{22}$

$15 - 6I_1 - 2I_3 - 4I_4 = 0$

$15 - 6I_1 - 2I_2 + 8 - 4I_4 = 0$

$15 - 10I_1 - 2I_3 = 0$

$23 - 10I_1 - 2I_2 = 0$

$15 - 10I_2 - 10I_3 - 2I_3 = 0$

$23 - 10I_2 - 10I_3 - 2I_2 = 0$

$2I_3 + 8 - 2I_2 \to I_3 + 4 = I_2$

$15 = 12I_3 + 10I_3 + 40$

$15 - 10I_2 - 10I_3 - 2I_3 = 23 - 10I_2 - 10I_3 - 2I_2$

$12I_3 + 10I_2 - 15 = 10I_3 + 12I_2 - 23$

$I_3 = -\frac{25}{22}$

$V_A = 4'63$ V

$V_B = 6'9$ V

$V_A \begin{cases} 2I_2 - 8 + 4I_4 = \frac{126}{22} - 8 + \frac{152}{22} = \frac{102}{22} = 4'63 \text{ V} \\ -6I_1 + 15 = 15 - \frac{228}{22} = \frac{102}{22} = 4'63 \text{ V} \\ 2I_3 + 4I_4 = \frac{152 - 50}{22} = 4'63 \text{ V} \end{cases}$

$V_B \begin{cases} 4I_4 = \frac{152}{22} = \frac{76}{11} = 6'90 \text{ V} \\ -2I_3 - 6I_1 + 15 = \frac{50}{22} - \frac{228}{22} + 15 = \frac{152}{22} = 6'90 \text{ V} \\ 8 - 2I_2 - 6I_1 + 15 = 8 - \frac{126}{22} - \frac{228}{22} + 15 = \frac{152}{22} = 6'90 \text{ V} \end{cases}$

EA - I - 006

Zenbaitetan, beste material batzuekin nahasten dira kristalak.

Ohiko taulan III zutabean ⇒ BOROA

IV zutabean ⇒ GERMANIOA, SILIZIOA

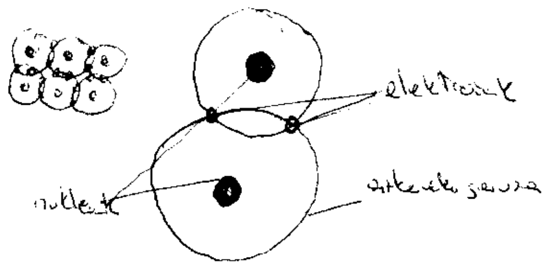
V zutabean ⇒ FOSFOROA, ARTSENIKOA, ANTIMONIOA

VI zutabean ⇒ SELENIOA, TELEROA

↳ Azkeneko orbitako elektroi kopurua

Konposatuak ⇒ GaAs ⇒ ARTSENIO GALIOA

<u>Silizioko kristala</u>



Kristala sortzean, lau atomoek konpartitu eta horrela zortzi elektroia azkeneko geruzan.

→ **Egonkor** bihurtzen dira elektroiak konpartitzerakoan, egitura "osatu" egiten da.

→ Lotura kobalentea dago. <u>**Zurruntasuna**</u> ematen dio kristalari lotura horiek.

→ Tenperatura zero absolutua denean gero (**0°K**), elektroi guztiak beren orbitetan finkatuta daude eta silizioa <u>**isolatzaile perfektua**</u> dela esan daiteke.

→ Tenperatura normal batean, elektroi batzuk askatu egiten dira, nahiz eta erresistibitatea handia den. Ez da isolatzaile perfektua, baina gertu dago.

→ Gero eta energia hartzean elektroiak bibratzen hasten dira eta batzuk bat aska daiteke. Utzitako lekuari <u>**hutsunea**</u> deituko diogu. Hutsune horiek <u>karga positibo bezala</u> jokatzen du. Edozein momentutan beste elektroi bat erakar dezake.

→ Elektroi aske bat hutsune batean kokatzen denean, <u>**birkonbinatu**</u> egin dela esaten dugu. Elektroi askea sortzen eta desagertzen den bitarteari <u>**bizitza denbora**</u> deritzogu.

$n = p = n_i$ → kontzentrazio intrintsekoa

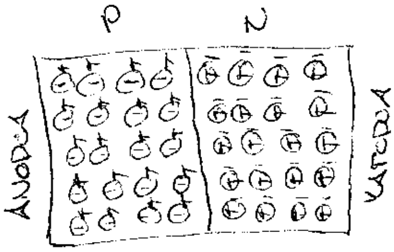
(p ↳ hutsuneak; n ↓ elektroi askeak)

* Elektroi hutsune pareak sortuko dira beroaren energiaz. $e^- - h^+$

EA-J-008

→ **Difusioko korronteak:** eroankortasun kontzentrazioen aldaketa espazialen eraginez sortutako korronteak. Elektrikoa jotzeko joera dute edo erasotako ildoen baterako ematen da fenomenoa.

PN Lotura edo diodoa (Etengailu elektronikoa)

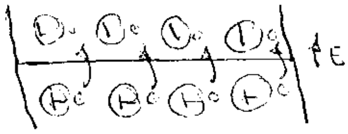


Dopatutako siliziozko kristala. Erdia tribalentea, erdian pentabalentea.

[+ / (−)] => Ezpurutasun tribalentea { + => hutsunea; − => ioi negatiboa

[− / (+)] => Ezpurutasun pentabalentea { − => elektroi askea; + => ioi positiboa

Juntura zonan normalean elektroi askeek bestaldera salto egiten dute. Momentu batean eremu elektriko txiki bat sortzen da pasoa eragotziz doena. Bikote bakoitzari dipolo deitzen zaio.

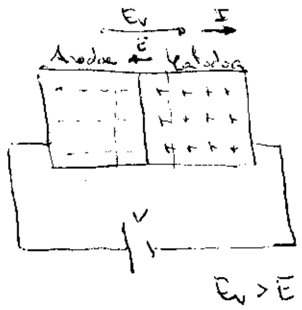


* Dipolo bat sortzen dira: ioi neg. + ioi pos.

Deplexio-zona deituriko garraiatzaileak gabeko zona sortzen da.

Kontrako tentsio bat jarriz gero, sortzen den eremua gainditu daiteke. Siliziozkoaren kasuan 0,7V da minimoa. Germaniozkoaren kasuan 0,2-0,3V behar dira.

Polarizazio zuzena



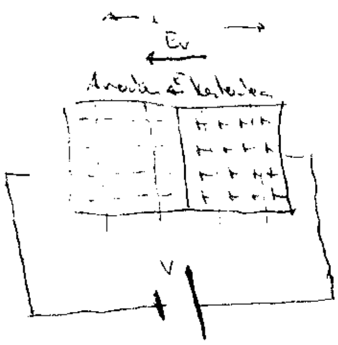
Honela polarizatuta, diodoak ia ez dio korronteari oztoporik egiten.

1/ Elektroi askeak loturarantz joango dira, eremu elektrikoaren eraginez.

2/ N aldean ioi positiboak geratzen dira, eta hauek terminal negatiboan dauden elektroiak erakartzen dituzte.

3/ Elektroi askeak birkonbinatu egiten dira hutsuneekin eta hutsune batetik bestera mugituz, azkenean terminal positibora heltzen dira.

Alderantzizko polarizazioa



Honela polarizatuta, diodoak oztopo handia egiten dio korronteari. Esan daiteke etengailu ireki edo isolatzaile gisa jokatzen duela. Pasatzen den korrontea oso txikia da.

Sortuko diren ioiak direnez anderantz, deplexio zona handitu egingo da. Zenbat eta tentsio gehiago jarri, orduan eta zabalagoa izango da deplexio zona.

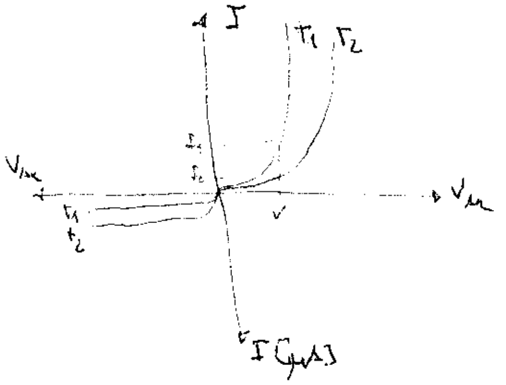
Garraiatzaile urrien korrontea izango da korronte bakarra, termikoki sortutako garraiatzaileena. Tenperatura 0K balitz, korrontea nulua litzateke. Tenperaturarekiko aldakorra da, baina T>10°C → korrontea bikoiztu.

1/ Lotura inguruan elektroi hutsune pare bat sortzen da energia termikoaren eraginez.

2/ Elektroia eskuinera doa, katodorantz, eta kristaleko ezkerraldetik elektroi bat ateratzen da eskuinaldetik.

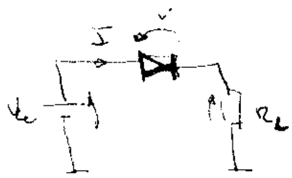
3/ Hutsunea ezkerrerantz doa eta kristaleko ezkerraldetik elektroi bat sartzen da. Birkonbinatu egiten da beste hutsune batekin.

Asetasun (alderantzizko) korrontea deitzen zaio.



$T_2 > T_1$

Kargako zuzena. Q lan-puntuaren kalkulua grafikoki:

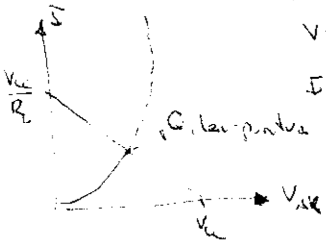


$Q\,[V_Q, I_Q]$ → tentsioa eta korrontea diodoan zirkuitu horretan

$V_{cc} = V + R_L I$ Kargako zuzena $(y - y_1) = m(x - x_0)$

$V = 0 \quad V_{cc}/R_L = I$

$I = 0 \quad V_{cc} = V$

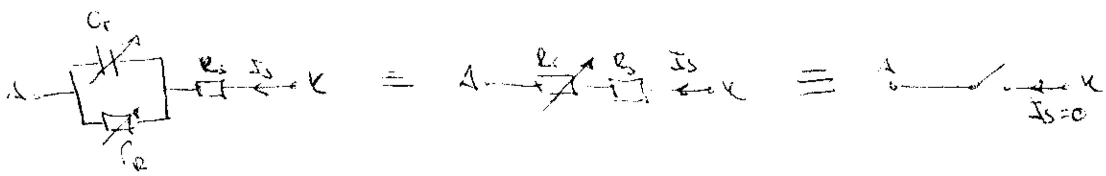


→ Analisi grafikoa

$$I = I_S\left(e^{\frac{qV}{kT}} - 1\right)$$
$$V_{cc} - V - R_L I = 0$$
→ Analisi matematikoa

Diodoaren zirkuitu baliokideak

→ Alderantziz polarizaturik dagoenean

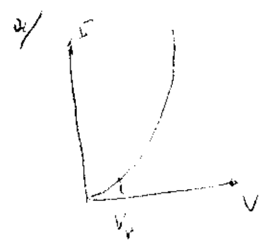


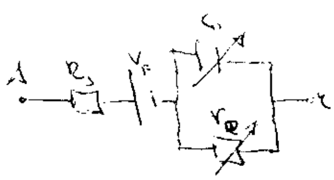
C_T → Kapazitate dinamikoa alderantziz polarizaturik. Balioa 3 ...

r_R → Alderantzizko erresistentzia dinamikoa $> 1 M\Omega$

R_S → Diodoak, materialak, duen erresistentzia $\approx \Omega$.

→ Zuzen polarizaturik dagoenean





R_S → materialaren erresistentzia

V_γ → atari-tentsioa

C_D → kapazitate dinamikoa zuzen polarizaturik

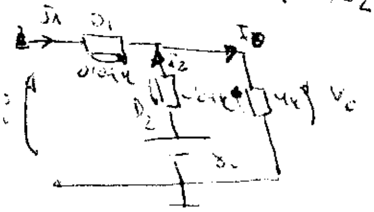
r_D → Erresistentzia dinamikoa zuzen polarizaturik

EA: 012

$V_A > V_K + V_F$ direct polarization of D_1 in positive

$V_i > V_c$; V_i: 1'52 V

$V_i > 1'52V \Rightarrow D_1 \, on, D_2 \, on$



$I_1 + I_2 = I_0$

$V_i - 0'04 I_1 + 0'04 I_2 - 8 = 0$

$V_i - 0'04 I_1 - 4 I_0 = 0$

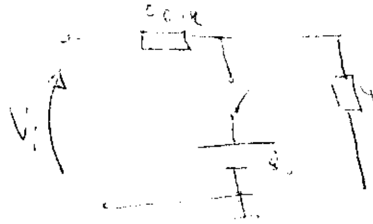
$I_1 = 16'32 V_i - 125'3$

$I_2 = \frac{32'32 - 4V_i}{0'32}$

$$V_0 = V_i - 0'04 I_1 = \boxed{\frac{0'64 V_i + 5'12}{1'3}}$$

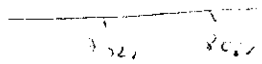
D_1 on, D_2 off $\Rightarrow I_2 \leq 0$

$I_2 = \frac{32'32 - 4V_i}{0'32} \leq 0 \Rightarrow V_i \geq 8'08 V$



$V_0 = \frac{V_i}{4 + 0'04} \cdot 4 = 0'99 V_i$

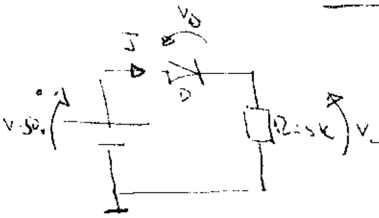
Solution in summary



$V_0 = 1'52 V$	$V_0 = \frac{0'64 V_i + 5'12}{1'3}$	$V_0 = 0'99 V_i$
D_1 OFF, D_2 ON	D_1 ON, D_2 ON	D_1 ON, D_2 OFF

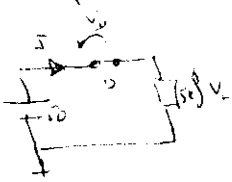
D OFF $\Rightarrow$ D ON $\Rightarrow V_A > V_K + V_F$

D ON $\Rightarrow$ D OFF $\Rightarrow I \leq 0$



I, V_D, V_L, P_D? Calculate using the different diode models.

a/



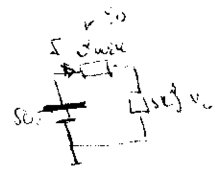
$I = \frac{V}{R} = \frac{50V}{5K} = 10mA$

$V_D = 0$

$V_L = 50V$; $5K \cdot 10mA = 50V$

$P_D = V_D \cdot I = 0W$

b/



$V_F = 0$

$r_F = \frac{1}{0'5A} = 2\Omega = 0'002k\Omega$

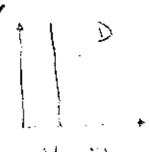
$I = \frac{50V}{5 + 0'002k} = 9'99mA$

$P_D = 0'02 \cdot 9'99mA \cdot 0'2 mW$

$V_D = 9'99mA \cdot 0'002k = 0'02V$

$V_L = 5K \cdot I = 49'98V$

c/



$V_F = 0'7$

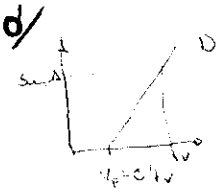
$I = \frac{50V - 0'7V}{5K} = 9'86mA$

$V_D = 0'7V$

$V_L = 5K \cdot I = 49'3V = 50 - 0'7V$

$P_D = V_D \cdot I = 0'7V \cdot 9'86mA = 6'9mW$

d/



$V_F = 0'7V$

$r_F = \frac{1V}{0'5A} = 2\Omega = 0'002k$

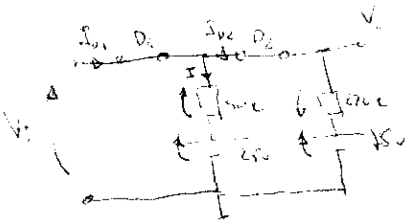
$I = \frac{50 - 0'7}{5 + 0'002k} = 9'85mA$

$V_D = r_F I + V_F = 0'72 V$

$P_D = V_D \cdot I = 7 mW$

$V_L = 5K \cdot I = 49'25V$

EA I 014



$I_{D1}+I_{D2}=I$

$V_i - 50I - 25 = 0$

$V_i + 220 I_{D2} - 75 = 0$

$I = \frac{V_i - 25}{50}$

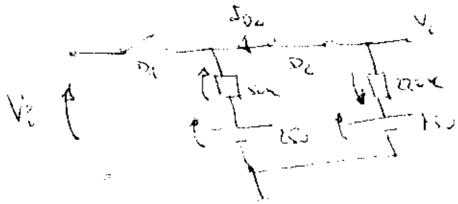
$I_{D2} = \frac{75 - V_i}{220}$

$I_{D1}: 0'0245 V_i - 0'841$

Funtzionamendua V_i eta V_o lotzen dituen kurba bat ikusi nahi da, beraz V_i, V_o aldatu, eta diodo kontrolatzen lagungarria kalkulatu behar.

$D_1 ON \Rightarrow D_1 OFF \Rightarrow I_{D1} \leq 0$

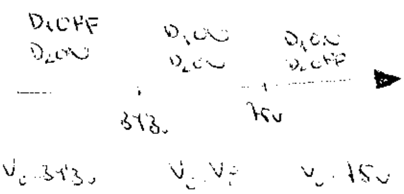
$0'0024 V_i - 0'841 \leq 0 \Rightarrow$ $V_i \leq 34'3 V$

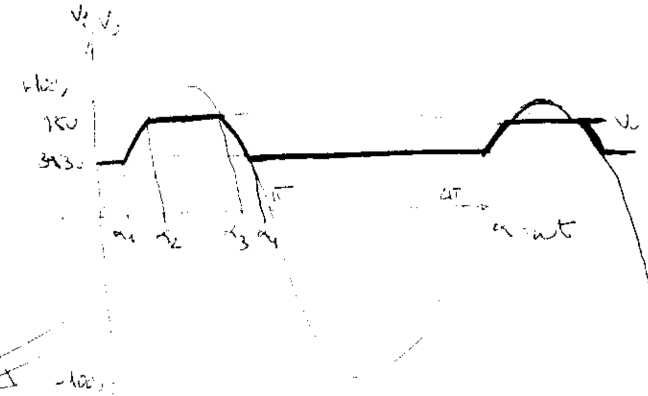


$25 + 50 I_{D2} + 220 I_{D2} - 75 = 0$

$\frac{50}{270} = I_{D2} = 0'185\ mA$

$V_o = -220 I_{D2} + 75 = -220 \cdot 0'185 + 75 =$ $34'3 = V_o$



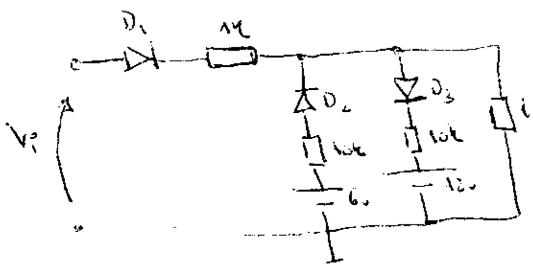


$V_i = 100 \sin \alpha_1 = 34'3 \Rightarrow \alpha_1 = \arcsin \frac{34'3}{100}$

$\alpha_4 = \pi - \alpha_1$

$100 \sin \alpha_2 = 75 \Rightarrow \alpha_2 = \arcsin \frac{75}{100}$

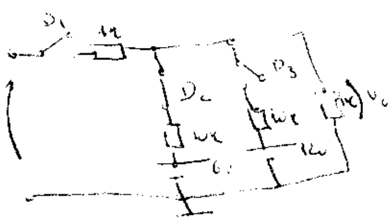
$\alpha_3 = \pi - \alpha_2$



$V_o = f(V_i)$? $V_i = -\infty$ .... $V_i = \infty$

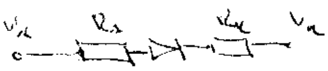
Deskribatu

V_i bb < ? 0'54 $\Rightarrow D_1 OFF, D_2 ON, D_3 OFF$

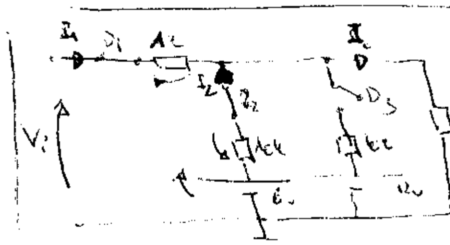


$V_o = \left(\frac{6}{10+1}\right) \cdot 1 = \frac{6}{11}$ $0'54 V$

V_i aldatu ahala, zirkuitoan agertu ahala, D_2 eta D_3 diodoak eroale egoeran aldatuko. $D_1 ON$ egin behar dan baldintzetako bestela, kontuan izanda ...



$D ON \Rightarrow V_A > V_K + V_F$ $V_i > V_o - 0'54 V$



$V_o = 1 I_o =$ $\frac{10 V_i + 6}{21} V$

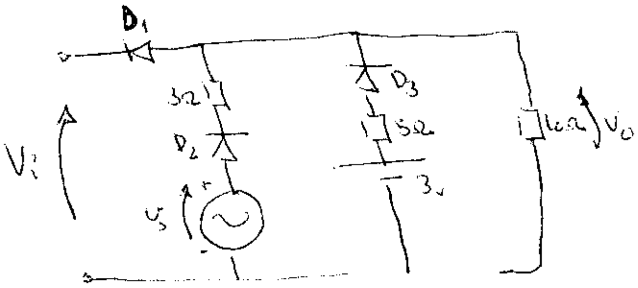
$I_1 + I_2 = I_o$

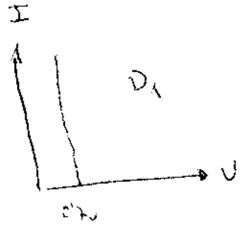
$V_i - 1 I_1 + 10 I_2 - 6 = 0$

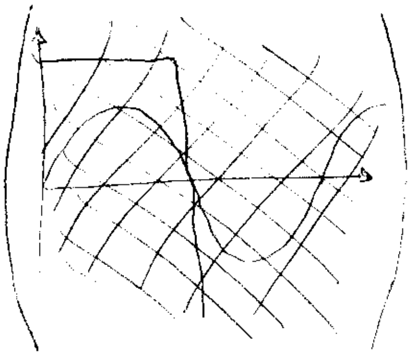
$V_i - 1 I_1 - 1 I_o = 0$

$I_1 = \frac{11 V_i - 6}{21}$ $I_2 = \frac{12 - V_i}{21}$ $I_o = \frac{10 V_i + 6}{21}$

EA - J - 16



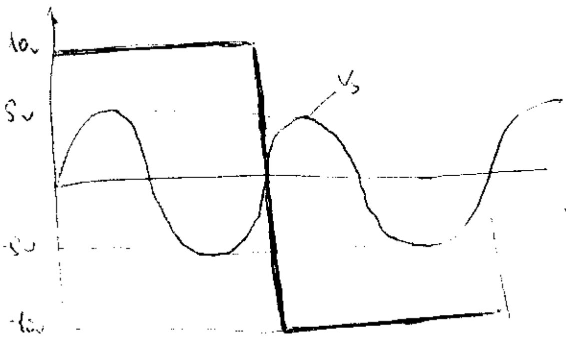




D_2, D_3 idealak

$V_0 = f(V_i, V_s)$?

D_1 $V_i = 10v$, $V_i = -10v$



$V_s = 5\sin\omega$

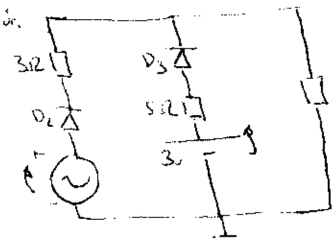
$V_i = \pm 10v$

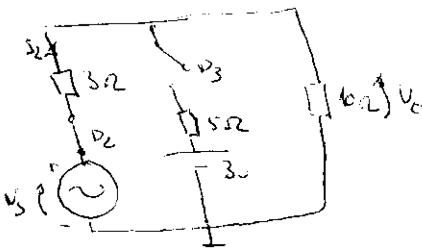
[illegible]

$V_i = +10v \Rightarrow D_1 OFF, D_2 ON, D_3 OFF$

$V_s > ?^{3.9v}$

$V_0 \left(\frac{V_s}{10+3} = \frac{V_s}{13}\right) \cdot 10 = \boxed{\frac{10V_s}{13}}$

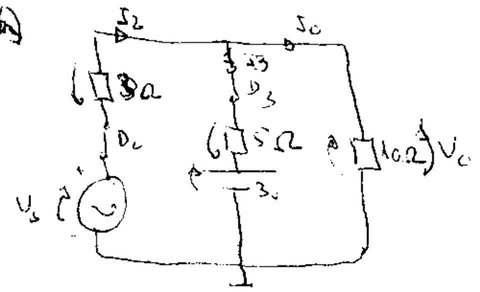




$D_2 ON \Rightarrow D_2 OFF \Rightarrow I_2 \leq 0 \Rightarrow \frac{V_s}{13} \leq 0 \Rightarrow V_s \leq 0$

$D_3 OFF \Rightarrow D_3 ON \Rightarrow V_A > V_K + V_F \Rightarrow 3v > \frac{10V_s}{13} \Rightarrow \frac{39}{10} > V_s \Rightarrow \boxed{3.9v > V_s}$

$3.9v > V_s > ?$ $D_2 ON, D_3 ON$



$I_0 = I_2 + I_3$

$V_s - 3I_2 - 10I_0 = 0$

$V_s - 3I_2 + 5I_3 - 3 = 0$

$I_2 = \frac{3V_s - 6}{19}$

$I_3 = \frac{1}{5} \cdot \frac{6V_s - 12}{57}$

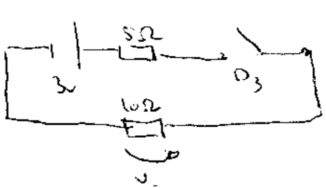
$V_0 = 10 \cdot I_0 = \boxed{\frac{10V_s + 18}{19}}$

$I_0 = \frac{5V_s + 9}{95}$

$D_2 ON \Rightarrow D_2 OFF \Rightarrow I_2 \leq 0 \Rightarrow$ ~~$\left(\frac{1}{5} \frac{6V_s - 12}{57} \dots V_s \leq 2\right)$~~

$\frac{3V_s - 6}{19} \leq 0 \Rightarrow V_s \leq 2$

$2 \geq V_s > ?$ $D_2 OFF, D_3 ON$



$V_0 = \left(\frac{3}{5+10}\right)^{=I} \cdot 10 = 2v$

$D_1 OFF$, $D_2 ON$, $D_3 OFF$ ← 2	$D_1 OFF$, $D_2 ON$, $D_3 ON$	3.9 $D_1 OFF$, $D_2 OFF$, $D_3 ON$
$V_0 = 2v$	$V_0 = \frac{10V_s + 18}{19}$	$V_0 = \frac{10V_s}{13}$
	$V_0 = \frac{50\sin\alpha + 18}{19}$	$V_0 = \frac{50\sin\alpha}{13}$

BATEZBESTEKO BALIOA ETA BALIO EFIKAZA

Batezbesteko balioa => $S_{cc} = \frac{1}{T}\int_{t_1}^{t_2} s\,dt = \frac{1}{2\pi}\int_{\alpha_1}^{\alpha_2} s\,d\alpha$

Seinale periodikoekin erabiltzen dira.

Balio efikaza => $S_{ac} = \sqrt{\frac{1}{T}\int_{t_1}^{t_2} s^2 dt} = \sqrt{\frac{1}{2\pi}\int_{\alpha_1}^{\alpha_2} s^2 dt}$

Bi modutara adierazi daiteke $t \rightarrow \alpha = \omega t = 2\pi f t$

$S_{ac} \geq S_{cc}$ Seinalea konstantea bada $S_{ac} = S_{cc}$

! S orokorrean letra da, baina tentsioa, korrontea eta potentzia kalkulatzen dira

S_{ac} => rms (root mean square) (valor medio cuadrático)

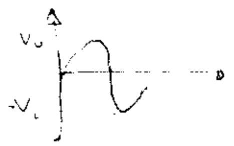
Erabilerak

Balio efikaza => $P = R I_{ac}^2 = V_{ac} \cdot I_{ac}$

Batezbesteko balioa => $\frac{1}{T V_{cc}}$ => $P = V_{cc} \cdot I_{cc}$

! Tentsio bat duela baldin badago seinale alterno bati erreferentzia egiten, balio efikazaz ari garela da. Errealitatean ...

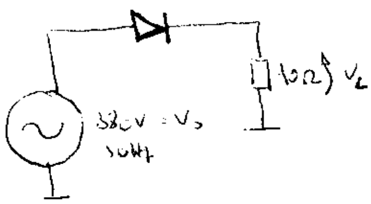
! Seinale alterno baten batezbesteko balioa 0 da.



$V_{ac} = \frac{V_0}{\sqrt{2}}$ Balio efikaza

$V_0 = 220\sqrt{2}$ ← Seinale alterno sinusoidal baten balio efikaza

ANALISI TERMIKOA



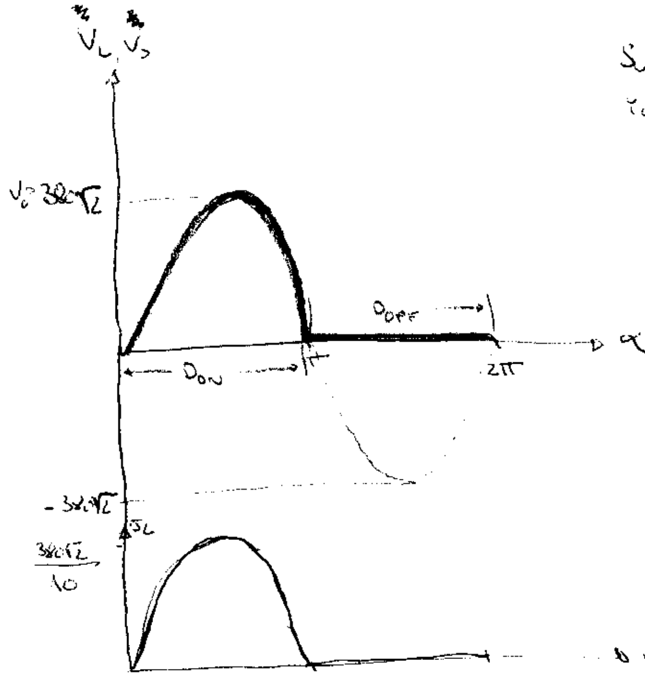
$P_D = V_{TO} \cdot I_{DC} + r_F \cdot I_{ac}^2$

Suposatu hasiera batean diodoa idealtzat dela.

$V = RI$

$I = \frac{V}{R}$

Ondoko zirkuitua aztertu eta aukeratu diodoa. Kalkulatu ere $V_{cc}, V_{ac}, I_{cc}, I_{ac}$.

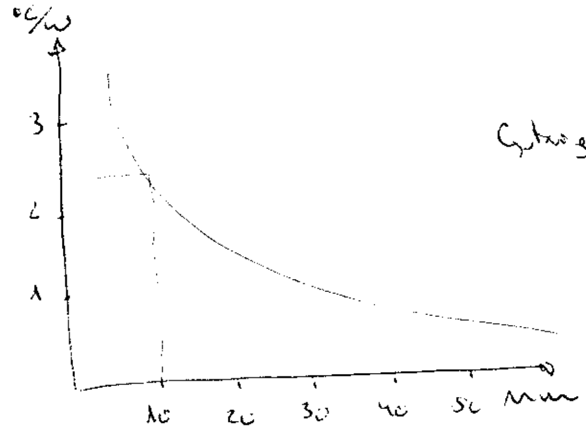


$$\theta_{THSA} = \frac{T_J - T_A}{P_D} - \theta_{THJC} - \theta_{THCS} = \frac{150°C - 60°C}{22'5W} - 2°C/W - 1°C/W = \boxed{25\ °C/W}$$

Erradiadorearen erresistentzia termikoa menorra.

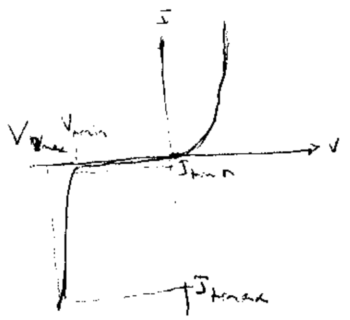
! Emaitza negatiboa izanez gero, potentzia hori disipatzea ezinezkoa dela esan nahi du.

Erradiadore-profila erosiko dugu.

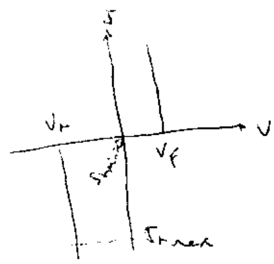


Gutxi gorabehera honako balioak ditugu.

HAUSTURAKO DIODOAK EDO ZENERRAK



Diodo normalek V_{min}-era heltzean apurtu egiten dira, zener diodoek funtzionatzen jarraitzen dute, bertako horietan ere funtzionatzeko prestatuta daude.



! Funtzionamendu sinplifikatua

! Zener tentsioan dagoenean, bere egiteko V_z konstante mantentzen da.

$$P_{max} = V_{max} \cdot I_{zmax}$$

HAUSTURAKO DIODOAK ZENER EFEKTUAREN ERAGINEZ

Zener tentsioa baino handiagoa jartzen dugunean, lotura kobalenteek lotura inguruan hautsi egiten dira eremu elektrikoaren eraginez eta horrela elektroi eta hutsune askeak sortzen dira, korrontea handituz.

Efektu hau zener tentsioa 6V baino txikiagoa den diodoetan baino ez da ematen.

HAUSTURAKO DIODOAK ZENER ELURRELOI (ABALANTXA) EFEKTUAREN ERAGINEZ

Diodo normaletan ematen den efektu bera da, baina hauek potentzia hori disipatzeko prestatuta daude eta ausreko posizioa bultzatzen dira.

Zener tentsioa 6V baino handiagoa dereko diodoetan ematen da.

EA-5-CL2

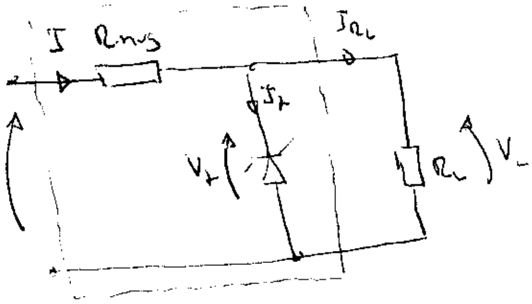
$V_i - R_{mug} I - V_z = 0$

$I = I_z + I_{RL}$

$V_z - R_L I_{RL} = 0$

$$R_{mug} = \frac{V_i - V_z}{I_z + I_{RL}}$$

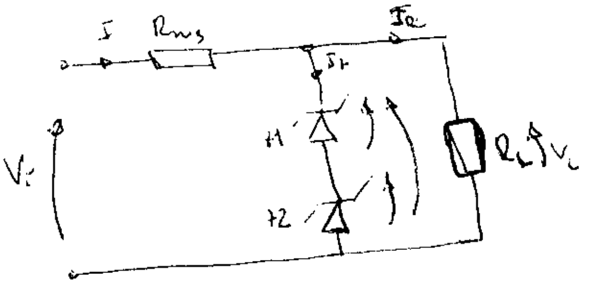
$$I_{RL} = \frac{V_z}{R_L}$$

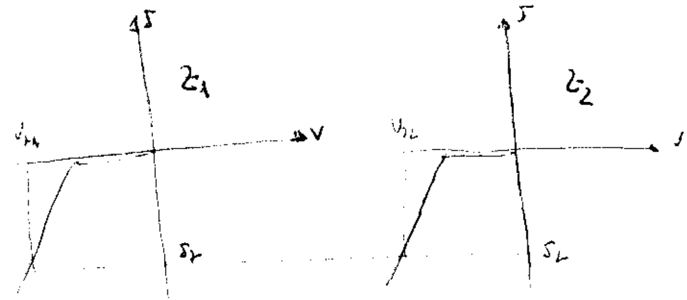


$$R_{mug\,max} = \frac{V_{i_{min}} - V_{z_{min}}}{I_{z_{min}} + I_{RL_{max}}}$$ ⇒ Erregulazioa engaltzeko

$$R_{mug\,min} = \frac{V_{i_{max}} - V_{z_{max}}}{I_{z_{max}} + I_{RL_{min}}}$$ ⇒ Ez erretzeko

ETAPA BATEKO ZIRKUITU EGONKORTZAILEAK DIODO BAT BAINO GEHIAGOREKIN

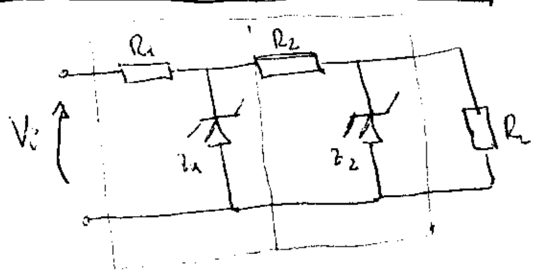




! V_L balioa handia bada zener bakarra jarri genezake, baina horrek balio altuko zener eta korronte elektriko handia eragingo luke. Hori dela eta, hobe dugu bi zener jartzea.

$$V_L = V_{Z1} + V_{Z2}$$

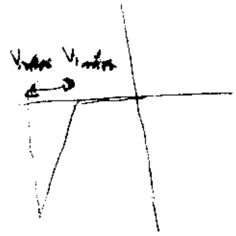
BI ETAPAKO EGONKORTZAILEA



$V_{Z1} >> V_{Z2}$ izanik

Bestela ez da egonkortzen

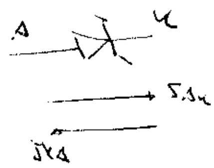
Lehenengo etapatik ateratzen den seinalea bigarrenean egonkortu egiten da.



OHARRA

Zenerra OFF ⇒ Zenerra ON Z.P. ⇒ $V_A > V_K + V_F$

Zenerra ON ⇒ Zenerra OFF Z.P. ⇒ $I_{AK} \le 0$

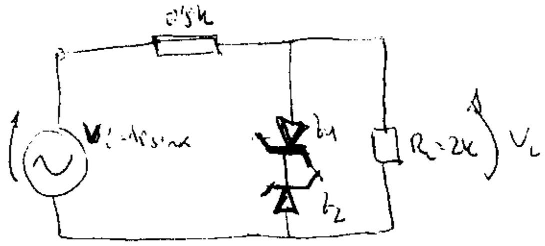


ZOFF ⇒ ZON A.P. ⇒ $V_K > V_A + V_Z$

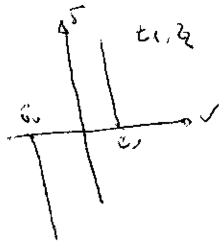
ZON ⇒ ZOFF A.P. ⇒ $I_{KA} \le 0$

! Egingo ditugun ariketetan $I_{Zmin} = 0$ bezala hartuko dugu. I_{Zmax} ere ahaztu egingo dugu.

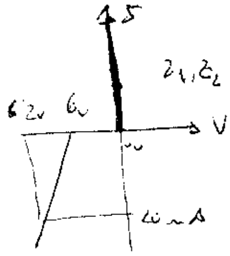
EA - J - 024



a)

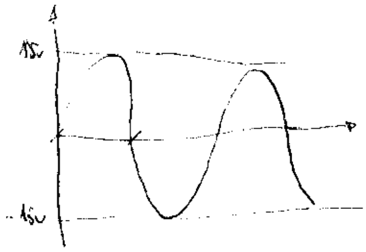


b)



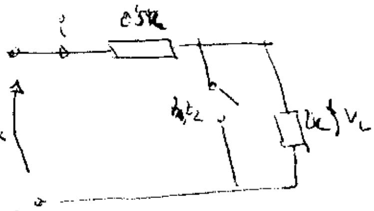
$V_L = f(V_i)$?

! Hau ez da zirkuitu egokia-tratatzeko



Z_1 eta Z_2 OFF

$V_i < ?$



$$V_L = \left(\frac{V_i}{0'5+2}\right) \cdot 2k = \boxed{\frac{2}{2'5} V_i} = \frac{30}{2'5}\sin\alpha = \boxed{12\sin\alpha}$$

Z_2 OFF $\Rightarrow$ Z_2 ON ΔP. $\Rightarrow$ $V_L > V_\lambda + V_Z$ $\Rightarrow$ $V_L > 0 + 6$ $\Rightarrow$ $\boxed{V_L > 6v}$, $V_L = \frac{2}{2'5} V_i$ } $V_i > 7'5V$

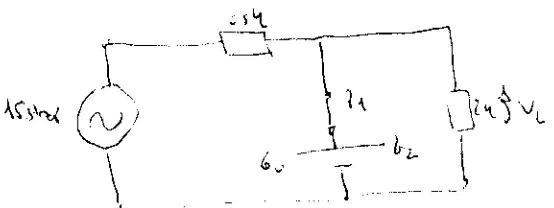
$V_L > V_\lambda + V_Z$

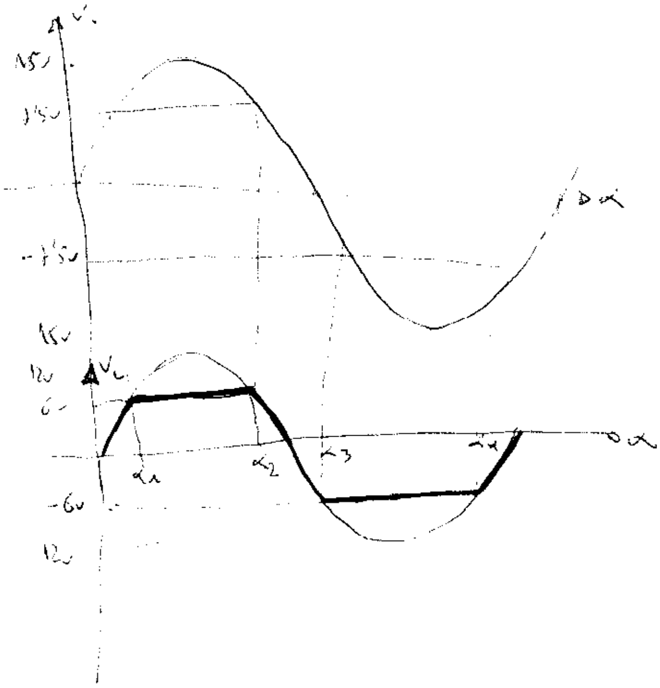
Z_1 ON AP, Z_2 ON P	Z_1 OFF, Z_2 OFF	Z_1 ON P, Z_2 ON AP

$\leftarrow$ -7'5 — 7'5 $\rightarrow$ V_i

$V_L = -6v$ $V_L = 12\sin\alpha$ $V_L = 6v$

$V_i > 7'5v$ Z_1 ON AP, Z_2 ON AP





! Kontuan izan kalkulagailuaren ekin. Begiratu DEG edo RAD dagoen.

$$\left.\begin{aligned} 15\sin\alpha &= 7'5 \\ 12\sin\alpha &= 6v \end{aligned}\right\} \alpha_1$$

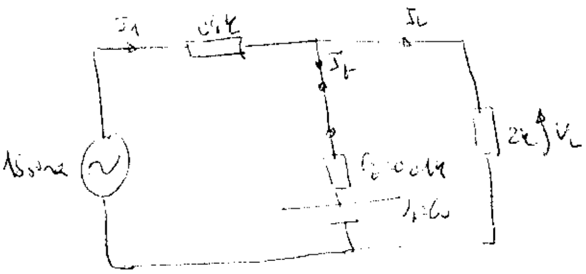
$\alpha_2 = \pi - \alpha_1$

$\alpha_3 = \pi + \alpha_1$

$\alpha_4 = 2\pi - \alpha_1$

b) kasua

$$r_Z = \frac{6'2-6}{0'02} \cdot 10\,\Omega = 0'01k \qquad V_Z = 6v$$



$I_1 = I_L + I_Z$

$V_i - 0'5I_1 - 0'01I_Z - 6 = 0$

$6 + 0'01I_Z - 2I_L = 0$

$I_L = 0'175\sin\alpha + 2'93 \Rightarrow V_L = 2I_L = 0'35\sin\alpha + 5'86$

Z_1 ON AP, Z_2 ON AP	Z_1 OFF, Z_2 OFF	Z_1 ON P, Z_2 OFF AP

$\leftarrow$ -7'5 — 7'5 $\rightarrow$ V_i

$V_L = 0'35\sin\alpha - 5'86$ $V_L = 12\sin\alpha$ $V_L = 0'35\sin\alpha + 5'86$

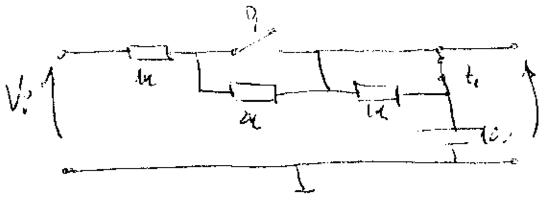
EA-I-026

$D_1 ON \Rightarrow D_1 OFF \Rightarrow I \leq 0 \Rightarrow \frac{V_i - 10}{2} \leq 0 \Rightarrow \boxed{V_i \leq 10v}$

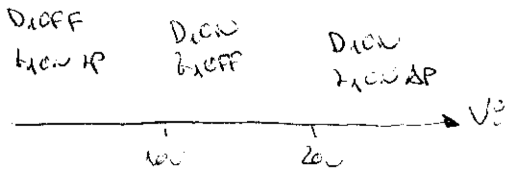
$t_1 OFF \Rightarrow t_1 ON$ r.p. $\Rightarrow V_A > V_K + V_{\gamma}$ $\Rightarrow V_A > V_K \Rightarrow V_A - V_K > 0 \Rightarrow -1 I = \frac{10 - V_i}{2} > 0 \Rightarrow V_i < 10v$

$10 > V_i$

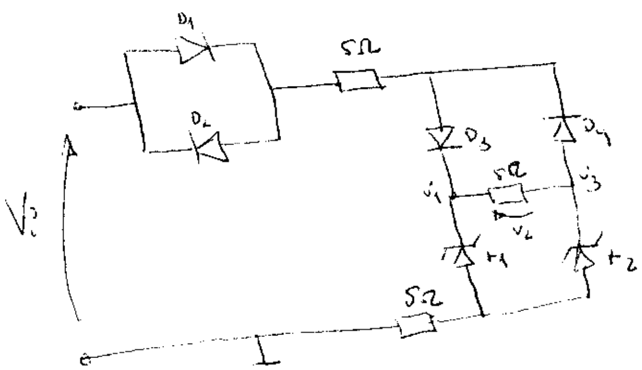
$D_1 OFF$, $t_1 ON$ r.p.

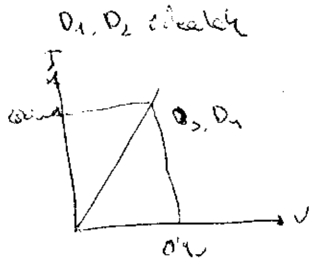


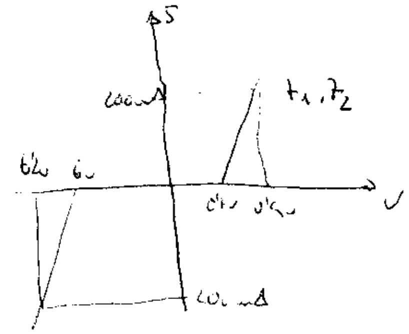
$V_0 = 10v$



$V_0 = 10v$ $V_0 = \frac{V_i + 10}{2}$ $V_0 = 15v$



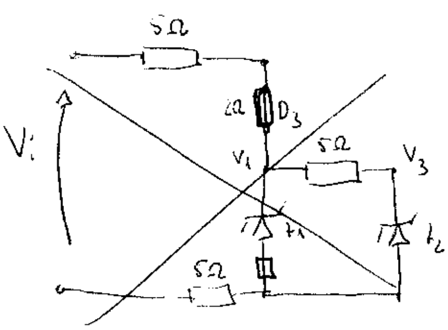


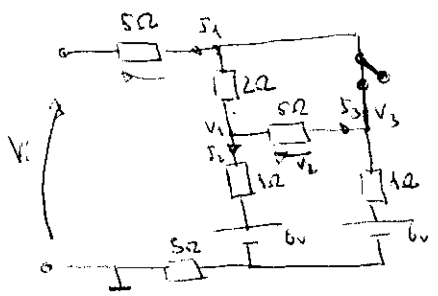


$D_3, D_4 \Rightarrow r_F = \frac{0'4}{0'2} = 2\Omega$ $t_1, t_2 \Rightarrow V_{\gamma} = 0'7v$ $r_F = \frac{0'9v - 0'7}{0'2} = 1\Omega$ $V_z = 6v$ $r_z = \frac{6'2 - 6}{0'2} = 1\Omega$

! D_1 eta D_2 diodoak, idealak izanda, eta ez dute eraginik zirkuituan. Beraz, ez ditugu kontuan hartuko, kendu egingo ditugu.

$V_i \uparrow\uparrow > ? \Rightarrow D_3 ON, D_4 OFF, t_1 ON AP, t_2 ON AP$





$I_1 = I_2 + I_3$

$V_i - (5+5+2)I_1 - 1I_2 - 6 = 0$

$6 + 1I_2 - (5+1)I_3 - 6 = 0$

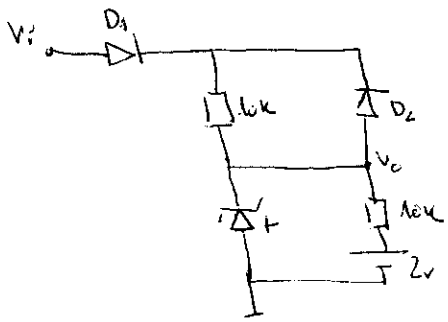
$I_1 = \frac{7V_i - 42}{90}$ $I_2 = \frac{V_i - 6}{15}$ $I_3 = \frac{V_i - 6}{90}$

$$V_1 = 5I_1 + 1I_2 + 6 = \frac{41V_i + 294}{90}$$

$$V_3 = 5I_1 + 1I_3 + 6 = \frac{36V_i + 324}{90}$$

$$V_2 = V_1 - V_3 = \frac{5V_i - 30}{90}$$

EA · 5 · 028



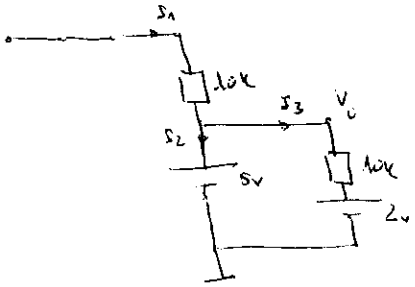
D_1, D_2 ideales

$t \Rightarrow$ ideal

$V_t = 5v$

$V_o = f(V_i)$?

$V_i \uparrow\uparrow$ D_1 ON, t_1 ON AP, D_2 OFF



$V_o = 5v$

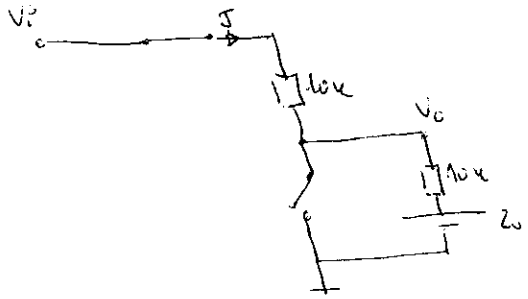
D_1 ON $\Rightarrow$ D_1 OFF $\Rightarrow$ $I_1 \leq 0$ $\Rightarrow$ $V_i \leq 5v$

$I_1 = \frac{V_i - 5}{10}$

t_1 ON AP $\Rightarrow$ t_1 OFF $\Rightarrow$ $I_2 \leq 0$ $\Rightarrow$ $I_2 = I_{D1} - I_3 = \frac{V_i - 5}{10} - \frac{5-2}{10} = \frac{V_i - 8}{10} \leq 0 \Rightarrow \boxed{V_i \leq 8v}$

D_2 OFF $\Rightarrow$ D_2 ON $\Rightarrow$ $V_A > V_K + V_F^{=0}$ $\Rightarrow$ $V_A - V_K > 0$ $\Rightarrow$ $-10 I_1 > 0$ $\Rightarrow$ $-V_i + 5 > 0$ $\Rightarrow$ $V_i < 5v$

$? < V_i \leq 8v$



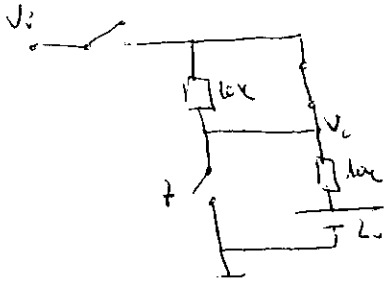
$I = \frac{V_i - 2}{10 + 10} = \frac{V_i - 2}{20}$

$V_o = V_i - 10 I = V_i - \frac{V_i - 2}{2} = \boxed{\frac{V_i + 2}{2}}$

D_1 ON $\Rightarrow$ D_1 OFF $\Rightarrow$ $I \leq 0$ $\Rightarrow$ $\frac{V_i - 2}{20} \leq 0$ $\Rightarrow$ $V_i \leq 2v$

D_2 OFF $\Rightarrow$ D_2 ON $\Rightarrow$ $V_A > V_K + V_F^{=0}$ $\Rightarrow$ $\frac{V_i + 2}{2} > V_i$ $\Rightarrow$ $V_i + 2 > 2V_i$ $\Rightarrow$ $2v > V_i$

t_1 OFF $\Rightarrow$ t_1 ON HP $\Rightarrow$ $V_A > V_K > V_F^{=0}$ $\Rightarrow$ $-V_o > 0$ $\Rightarrow$ $\frac{-V_i - 2}{2} > 0$ $V_i < -2v$

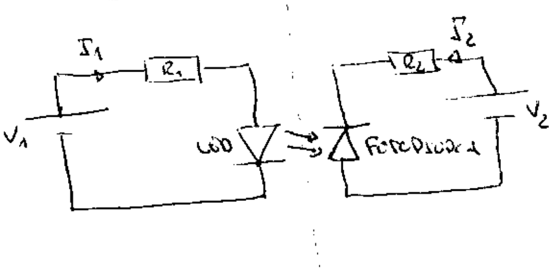


$V_o = 2v$ D_1 OFF, D_2 OFF 2.P.

OPTOAKOPLADOREAK

Diodo luminiszentea eta fotodiodoa aldi berean dituen elementua dugu.

$I_1 \uparrow \Rightarrow I_2 \uparrow$ LED-ak emititzen duen argia I_1-ekiko proportzionala dugu, baita fotodiodoak jasotakoa I_2-rekiko.

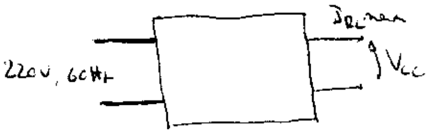


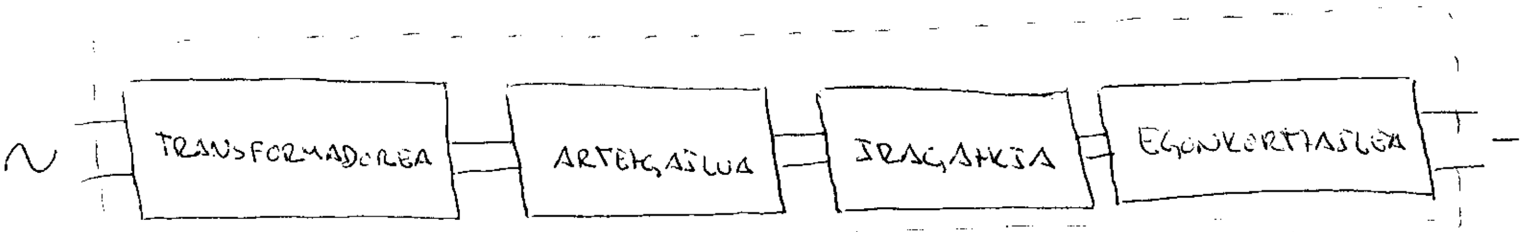
Fisikoki bi zirkuitu bereizteko erabiltzen da. Elektrikoki isolatuta geratzen dira horrela.

LASER DIODOA

Argia koherentea, laserra edo engelikoentzen emititzen dute. Aplikazioak: komunikazio optikoetan, distantziak neurtzeko, informazioa irakurtzeko, etab.

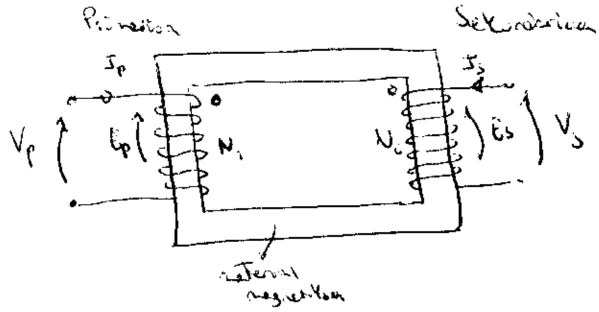
OINARRIZKO ELIKADURA ITURRIA





∼ / ∼	∼ / —	— / —	— / —
Tentsioaren balio eraginkorra aldatu egiten du, baina alternoa mantentzen du.	Seinalea zuzendu egiten du.	Seinalea konstanteago bihurtzen du.	Erabat konstante, egonkorra bihurtzen dute irteera.

TRANSFORMADOREA



Transformadore monofasikoa dugu hau.

$r_t = \frac{N_1}{N_2}$ → transformazio erlazioa $= \frac{\text{espira kopurua primarioan}}{\text{espira kopurua sekundarioan}}$

Voltaia netua, erlatiboa

$r_t = \frac{V_p}{V_s}$ $\quad P_p = P_s$ → $V_p \, I_p = V_s \, I_s$ → $\frac{V_p}{V_s} = \frac{I_s}{I_p}$

itxarotako potentzia

- Bi puntu horiek fasean daudela esan nahi du. Bata positiboa denean, bigarrena ere positiboan iragaten da, eta negatiboarekin berdin.

! Primarioan seinale aldakorra jarri behar da.

$$r_t = \frac{N_1}{N_2} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$$

Beti idealki? Kontuan hartuta

$I\sim$ = Osagai alternoaren balio efikazia.

Osagai alternoa kalkulatzeko, FOURIERREN DESKONPOSAKETA erabiliko dugu

$$i_{RL} = \underbrace{\frac{I_0}{\pi}}_{I_{Lq}} + \underbrace{\frac{I_0}{2}\sin\alpha - \frac{2I_0}{3\pi}\cos 2\alpha - \frac{2I_0}{15\pi}\cos 4\alpha + \dots}_{I_{RL\sim}}$$

$$i_{RL} = I_{Lq} + i_{RL\sim} \qquad i_{RL\sim} = i_{RL} - I_{Lq}$$

$$I\sim = \sqrt{\frac{1}{2\pi}\int_0^{2\pi}(i_{RL\sim})^2\,d\alpha} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi}(i_{RL} - I_{Lq})^2\,d\alpha} = \sqrt{I_{Le}^2 - I_{Lq}^2}$$

★1

$$r = \frac{I\sim}{I_{RLq}} = \frac{\sqrt{I_{RLe}^2 - I_{RLq}^2}}{I_{RLq}} = \sqrt{\frac{I_{RLe}^2 - I_{RLq}^2}{I_{RLq}^2}} = \sqrt{F^2 - 1} = \sqrt{1'57^2 - 1} = 1'21 \Rightarrow \%\,121$$

DIODOAK

$$I_{Do} = I_o = \frac{V_o}{r_f + R_L} \Rightarrow I_{FRM}$$

$$I_{De} = I_{RLe} = I_o/2 \Rightarrow I_{FRMS}$$

$$I_{Dq} = I_{RLq} = I_o/\pi \Rightarrow I_{FAV}$$

$$PIV = V_o \Rightarrow V_{RRM}$$

↓ Alderantzizko tentsio maximoa

Hauek begiratzeko diodoa dodoaren aukeraketarako.

TRANSFORMADOREA

$I_{RL} = I_L$

$$V_{se} = \frac{V_o}{\sqrt{2}}$$

$$V_{sq} = 0$$

$$V_{pe} = ct \cdot V_{se} = \frac{N_1}{N_2}\cdot\frac{V_o}{\sqrt{2}}$$

$$V_{pq} = ct \cdot V_{sq} = 0$$

$$I_{se} = I_{Le} = \frac{I_o}{2}$$

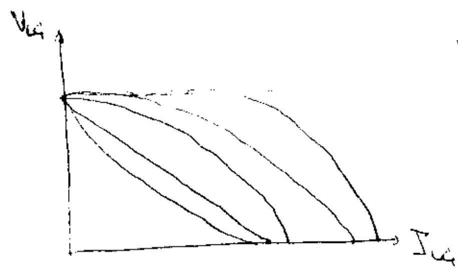
$$I_{sq} = I_{Lq} = \frac{I_o}{\pi}$$

$$I_{pe} = \frac{I_{se}}{ct} = \frac{I_o}{2}\cdot\frac{N_2}{N_1}$$

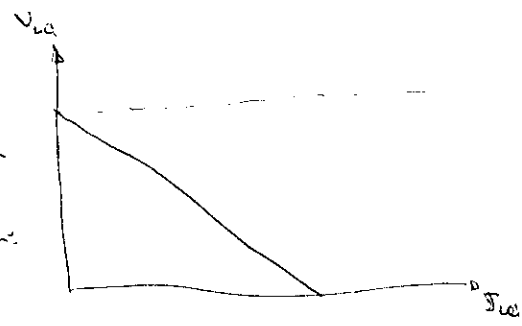
$$I_{pq} = \frac{I_{sq}}{ct} = \frac{I_o}{\pi}\cdot\frac{N_2}{N_1}$$

! Zirkuitu honek nukleoa negatiboki saturatzen du. Asetu egiten da nukleoa.
Hori dela eta, nahiz eta didaktikoki erabili, ez da benetan erabiltzen.

ERREGULAZIO KURBA



! Edozein osagaiekin gertatzen den fenomenoa dugu. Korrontea igotzean batera, tentsioa jaitsi egiten da.
Honetan fenomenoak dute korren errore erresistibo, kapazitiboa...



Sinplifikazioa: fenomeno erresistiboak bakarrik kontuan hartuta

EA - J - 0.34

$$I_{Lq} = \frac{1}{2\pi}\int_0^{2\pi} i_L \, \partial\alpha = \frac{1}{2\pi}\left[\int_0^{\pi} I_o \sin\alpha \, \partial\alpha + \int_{\pi}^{2\pi} I_o \sin(\alpha-\pi)\, \partial\alpha\right] = 2\cdot\frac{1}{2\pi}\int_0^{\pi} I_o \sin\alpha \, \partial\alpha = \frac{2 I_o}{\pi}$$

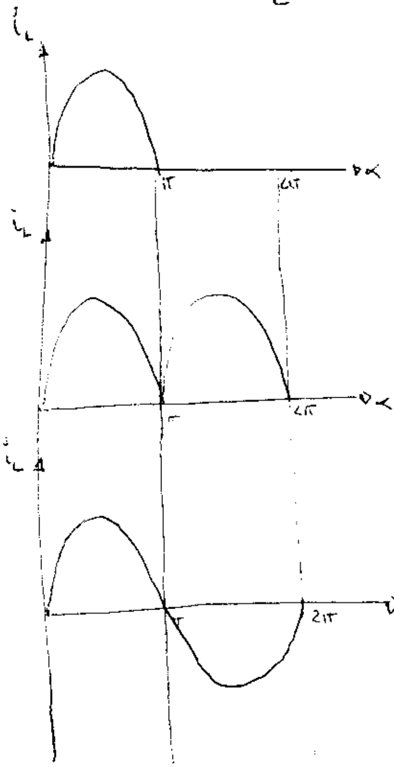
$$V_{Lq} = I_{Lq} R_L = \frac{2 I_o}{\pi} R_L$$

$$P_{Lq} = V_{Lq} I_{Lq} = \frac{4 I_o^2}{\pi^2} R_L$$

$$I_{Lc} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} i_L^2 \, \partial\alpha} = \sqrt{\frac{1}{2\pi}\cdot 2\int_0^{\pi} I_o^2 \sin^2\alpha \, \partial\alpha} = \frac{I_o}{\sqrt{2}}$$

$$V_{Lc} = I_{Lc} R_L = \frac{I_o}{\sqrt{2}} R_L$$

$$P_{Lc} = V_{Lc} I_{Lc} = \frac{I_o^2}{2} R_L$$



$I_{Lq} = \frac{I_o}{\pi}$ $\quad I_{Lc} = \frac{I_o}{2}$

$I_{Lq} = \frac{2 I_o}{\pi}$ $\quad I_{Lc} = \frac{I_o}{\sqrt{2}}$

$I_{Lq} = 0$ $\quad I_{Lc} = \frac{I_o}{\sqrt{2}}$

↓ Beterbesteko bukle bikoitzak
Baldo efikaz $\sqrt{2}$ aldiz handiagoak

$$P_S = P_{D1} + P_{D2} + P_{Lc} = 2P_{D1} + P_{Lc} = 2 r_F I_{D1}^2 + R_L I_{Lc}^2 = 2 r_F \left(\frac{I_o}{2}\right)^2 + R_L\left(\frac{I_o}{\sqrt{2}}\right)^2 = \frac{I_o^2}{R_L}(r_F + R_L)$$

$$\eta_i = \frac{P_{Lq}}{P_{Lc}} = \frac{\frac{4 I_o^2}{\pi^2} R_L}{\frac{I_o^2}{4} R_L} = \frac{8}{\pi^2} = 0'81 \Rightarrow \%81$$

$$\eta_c = \frac{P_{Lq}}{P_S} = \frac{\frac{4 I_o^2}{\pi^2} R_L}{\frac{I_o^2}{2}(r_F + R_L)} = \frac{8}{\pi^2}\left(\frac{R_L}{r_F + R_L}\right) < 0'81$$

$$F = \frac{I_{Lc}}{I_{Lq}} = \frac{I_o/\sqrt{2}}{2 I_o/\pi} = \frac{\pi}{2\sqrt{2}} = 1'11 \Rightarrow \%111$$

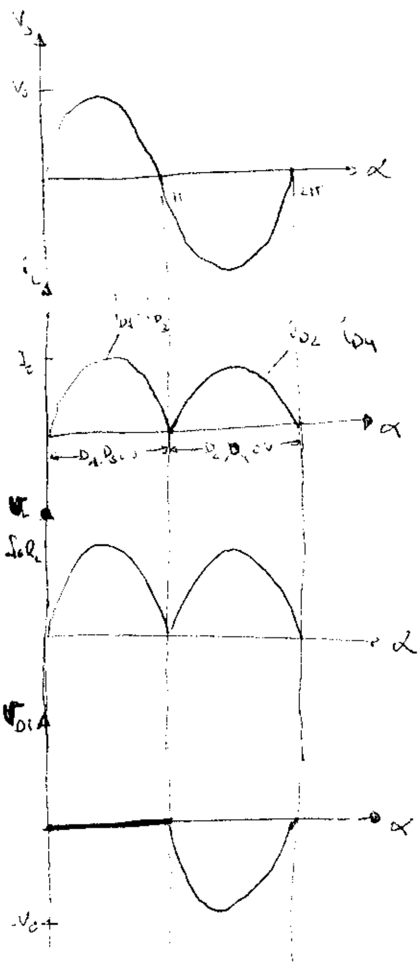
! Beste uhinen seinaleetan kalkulatu daitezke parametroak, nahiz eta kasu honetan komunitatean ezkutzik.

! Zenbat eta 1-etik hurbilago, uhinen eta hobe.

$$r = \frac{I_{\sim}}{I_{Lc}} = \sqrt{F^2 - 1} = \sqrt{1'11^2 - 1} = 0'48 \Rightarrow \%48$$

! Zenbat eta 0-tik hurbilago, uhinen eta hobe

EA - I - 036



diodo idealak suposatuz

$I_{Lcd} = \frac{2I_0}{\pi}$ $\quad V_{Lcd} = R_L I_{Lcd} = R_L \frac{2I_0}{\pi}$ $\quad P_{Lcd} = V_{Lcd} \cdot I_{Lcd} = \left(\frac{2I_0}{\pi}\right)^2 R_L = \frac{4I_0^2}{\pi^2} R_L$

$I_{Lc} = \frac{I_0}{\sqrt{2}}$ $\quad V_{Lc} = R_L \cdot I_{Lc} = \frac{I_0}{\sqrt{2}} R_L$ $\quad P_{Lc} = V_{Lc} \, I_{Lc} = \frac{I_0^2}{2} R_L$

$P_S = P_{D1} + P_{D2} + P_{D3} + P_{D4} + P_{Lc} = 4P_{D1} + P_{Lc}$

$= 4r_f I_{D1}^2 + \frac{I_0^2}{2} R_L = 4r_f \left(\frac{I_0}{2}\right)^2 + \frac{I_0^2}{2} R_L = \frac{I_0^2}{2}(2r_f + R_L)$

$\eta_i = \frac{P_{Lcd}}{P_{Lc}} = \frac{4I_0^2/\pi^2 \, R_L}{I_0^2/2 \; R_L} = \frac{8}{\pi^2} = 0'81 \Rightarrow \%81$

$\eta_c = \frac{P_{Lcd}}{P_S} = \frac{4I_0^2/\pi^2 \, R_L}{I_0^2/2 \, (2r_f + R_L)} = \frac{8}{\pi^2} \frac{R_L}{(2r_f + R_L)} < 0'81$

$F = \frac{I_{Lc}}{I_{Lcd}} = 1'11 \Rightarrow \%111$

$r = \frac{I_r}{I_{Lcd}} = 0'48 \Rightarrow \%48$

DIODOAK

$I_{D0} = I_0 = \frac{V_0}{2r_f + R_L}$ $\quad I_{Dcd} = \frac{I_0}{\pi} = \frac{I_{Lcd}}{2}$ $\quad I_{Dc} = \frac{I_0}{2} = \frac{I_{Lc}}{\sqrt{2}}$ $\quad PIV = V_0$

ERREGULAZIO KURBA

$V_{Lcd} = V_{Lcd,0} - 2r_f I_{Lcd} = \frac{2V_0}{\pi} - 2r_f I_{Lcd}$

ERREGULAZIO-PORTZENTAIA

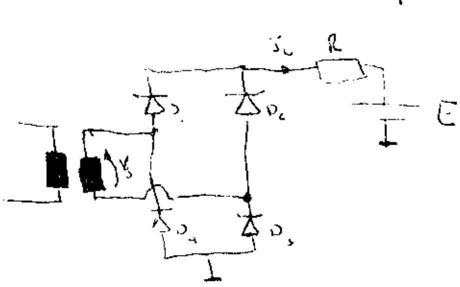
$\%REG = \frac{V_{Lcd,0} - V_{Lcd}}{V_{Lcd,0}} \cdot 100$

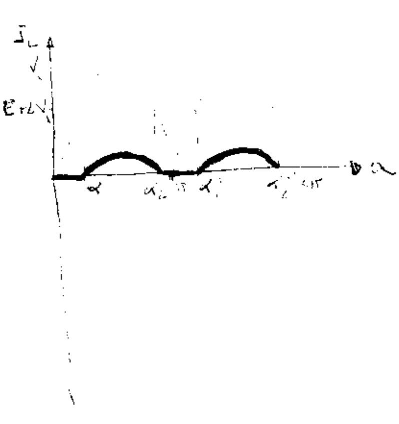
! Ehunekotan adierazten da, tentsioa zenbat jaisten den.

→ BATERIA KARGADOREA - ARTEZGAILUEN APLIKAZIO BAT

E: indar elektroeragilea: zenbat volt ematen dituen. [V]

C: kapazitatea [A·h] Kapazitatea = I_{Lcd} · denbora





$\alpha_1 < \alpha < \alpha_2 \Rightarrow i_L = \frac{V_S - E - 2V_\gamma}{R + 2r_f} = \frac{V_0 \sin\alpha - E - 2V_\gamma}{R + 2r_f}$

$I_0 = \frac{V_0 - E - 2V_\gamma}{R + 2r_f}$

$V_0 \sin\alpha_1 = E + 2V_\gamma \Rightarrow \alpha_1 = \arcsin \frac{E + 2V_\gamma}{V_0}$

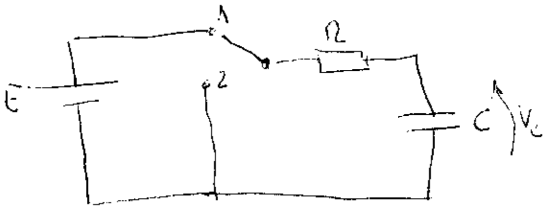
$\alpha_2 = \pi - \alpha_1$

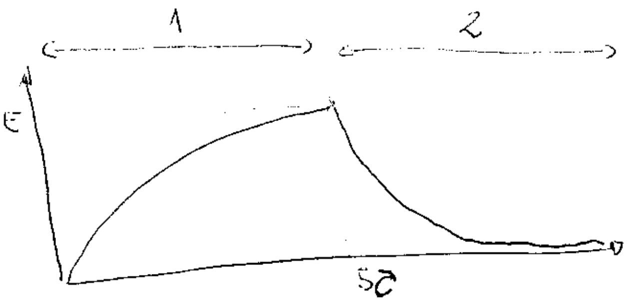
EA - I - 038

$$i = C\frac{du_c}{dt}$$

Kondentsadorearen ekuazioa

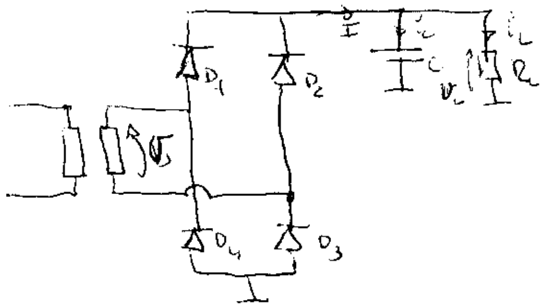
→ ANALISI FISIKOA

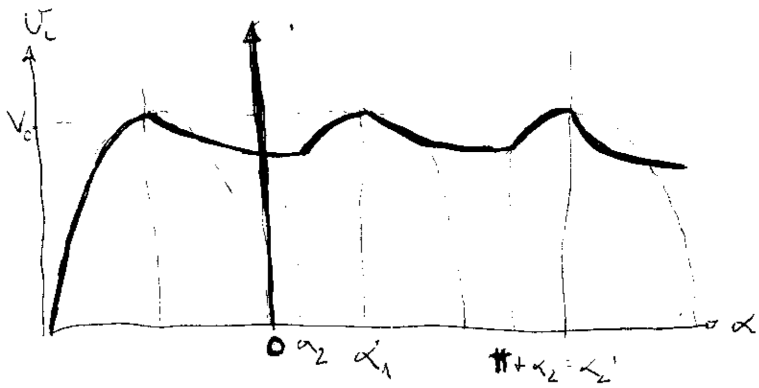




$\tau = RC$

→ KONDENTSADOREAREKO IRAGAZKIA





[illegible]

$V_c > V_s \Rightarrow D_1, D_3$ OFF

Bi uzgurabererizko diturak

DIODOAK BROATEN $\Rightarrow \alpha_2 < \alpha < \alpha_1$

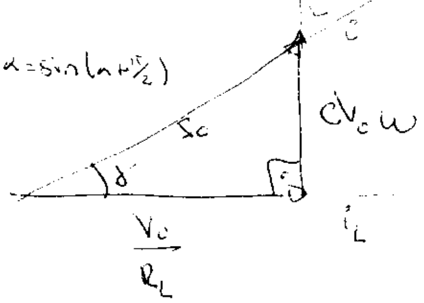
$$i = i_c + i_L \qquad i_L = \frac{U_L}{R_L} = \frac{U_s}{R_L} = \frac{V_0 \sin\alpha}{R_L}$$

$$i_c = C\frac{\partial u_c}{\partial t} = C\frac{\partial v_s}{\partial t} = C\frac{\partial(V_0\sin\alpha)}{\partial t}$$

$$C\omega\frac{\partial(V_0\sin\alpha)}{\partial(\omega t)} = C V_0 \omega \cos\alpha$$

$$i = \frac{V_0}{R_L}\sin\alpha + C V_0 \omega \cos\alpha$$

$\cos\alpha = \sin(\alpha + \pi/2)$



$$I_0 = \sqrt{\left(\frac{V_0}{R_L}\right)^2 + (CV_0\omega)^2}$$

$$tg\,\gamma = \frac{CV_0\omega}{V_0/R_L} = C\omega R_L$$

$$\gamma = arctg(C\omega R_L)$$

$$i = I_0 \sin(\alpha + \gamma)$$

$$\alpha = \alpha_1 \Rightarrow i = 0 = I_0 \sin(\alpha_1 + \gamma)$$

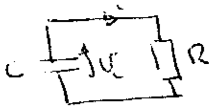
$$\sin(\alpha_1 + \gamma) = 0 \quad , \quad \alpha_1 + \gamma = \pi$$

$$\alpha_1 = \pi - arctg(\omega C R_L)$$

$$C\uparrow \Rightarrow \alpha_1 \downarrow \Rightarrow I_0 \uparrow$$

! Kondentsadorea zenbat eta handiagoa izan, orduan eta korrontearen itzurgoa i izango, baina korrontea ere handiagoa da. Horrek kondentsadorea eta diodoak sufritzea eragiten dute.

DIODOAK BLOKEATUTA $\Rightarrow \alpha_1 < \alpha < \alpha_2'$

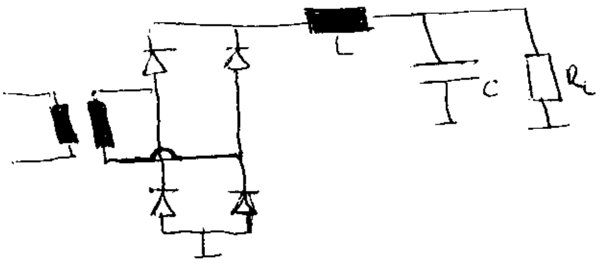


$U_L = U_C$

$$i = C\frac{\partial U_c}{\partial t} \; ; \; \partial U_c = \frac{1}{C} i\,\partial t$$

$$\left.\begin{aligned} U_c &= \frac{1}{C}\int i\,\partial t \\ U_L &= R_L \cdot i \end{aligned}\right\} \frac{1}{C}\int i\,dt = R_L i$$

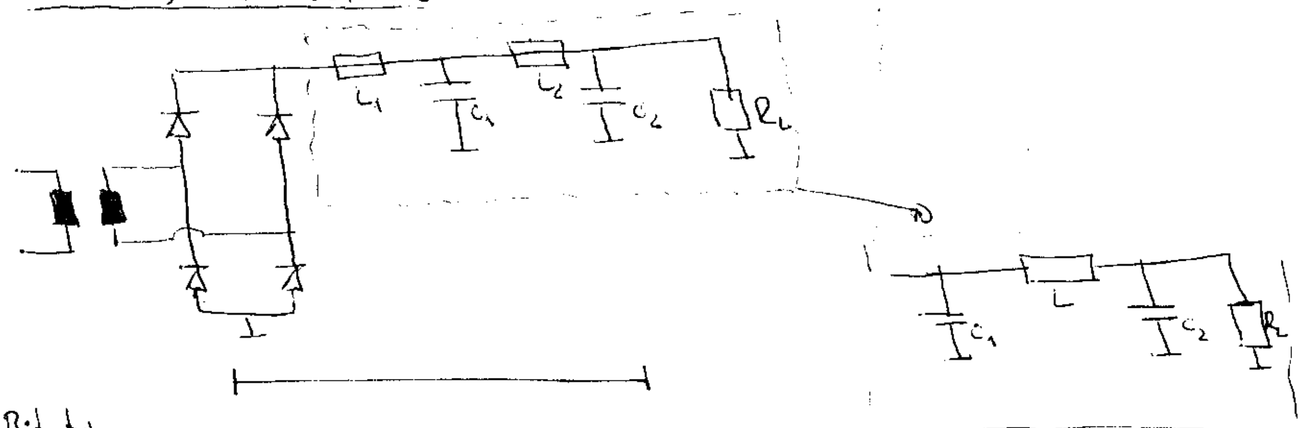
LC IRAGAZKIA



$$r \simeq \frac{\sqrt{2}}{12}\,\frac{1}{\omega^2 LC}$$

! R_L-ren eragina gutxi gora behera desestatu egiten da. Uhindura-maila baxuak izateko L eta C balioak altuak izango dira.

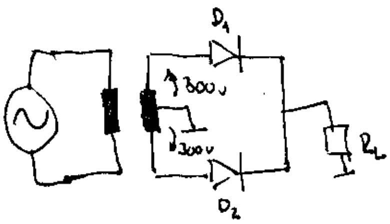
LC IRAGAZKI ANITZAK



Bitarteko hargunedun uhin osoko artezgailu bat osagai idealez osatua dugu, eta transformadorearen sekundarioaren fasetentsioa 300V / 50Hz da. Kalkulatu V_{LC_0} kargabarik irteeran. V_{LC} irteerako korrontea 100mA izanik. Zer gertatzen zaio uhindura mailari: I_{LC}-k gora egiten badu? Diodoen PIV tentsioa.

A/ Iragazkirik gabe

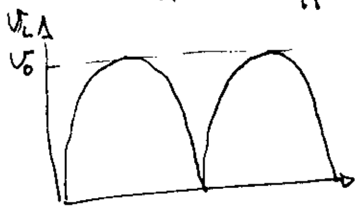
B/ Irteeran 10μF-ko kondentsadorea dugunean



! 300v balio efikazean da.
$V_0 = 300\sqrt{2}$

A kasua

! $V_{LC_0} = \frac{2V_0}{\pi} = \frac{2 \cdot 300\sqrt{2}}{\pi} = \boxed{270V}$

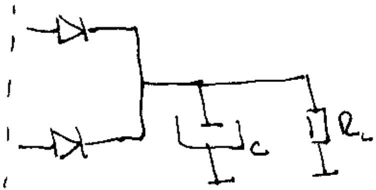


! Diodoak idealak izanik, berdin dio kargarik egotea edo ez, ezbaitago karga jauzirik. Beraz, $V_{LC} = V_{LC_0}$ $\boxed{270V}$

! $PIV = 2V_0 = 2 \cdot 300\sqrt{2} = \boxed{848V}$

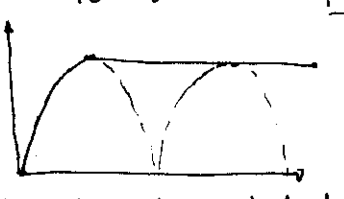
! Aipatutako baldintzak direla medio, uhindura-maila berdin mantentzen da.

B kasua



! $PIV = 2V_0 = 2 \cdot 300\sqrt{2}$ $\boxed{848V}$

! $V_{LC_0} = V_0 = 300\sqrt{2} = \boxed{424V}$



! Kargarik ez dagoenean, diodoak blokeatzean, kondentsadorea ez da deskargatzen, konstante mantentzen da.

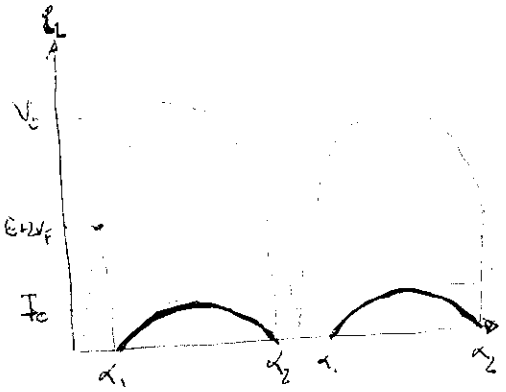
! $V_{LC} = V_0 - \frac{V_r}{2}$ $\quad V_r = \frac{I_{LC}}{2fC} = \frac{100 \cdot 10^{-3}}{2 \cdot 50 \cdot 10 \cdot 10^{-6}} = 100V$

$V_{LC} = 300\sqrt{2} - \frac{100V}{2} = \boxed{374V}$

! Uhindura-maila txarragoa, handiagoa, izango da I_{LC}-k gora egitean. Azkarrago hustuko da kondentsadorea korrontea gora egitean.

EA-J-042

Hondako bat egitoko da ... kontuan



$\alpha_1 < \alpha < \alpha_2 \Rightarrow i_L = \dfrac{V_0 \sin\alpha - E - 2V_F}{R_1 + R_2 + 2r_f}$

$V_0 \sin\alpha_1 = E + 2V_F \Rightarrow 30\sqrt{2}\, \sin\alpha_1 = 24 + 2 \Rightarrow \alpha_1 = \arcsin \dfrac{26}{30\sqrt{2}}$

$\alpha_1 = 0'654\,rad \Rightarrow \alpha_2 = \pi - \alpha_1 = 2'48\,rad$

$I_{Lq} = \dfrac{1}{2\pi} \cdot 2 \displaystyle\int_{\alpha_1}^{\alpha_2} \dfrac{V_0 \sin\alpha - E - 2V_F}{R_1 + R_2 + 2r_F}\, d\alpha = \dfrac{1}{\pi} \displaystyle\int_{\alpha_1}^{\alpha_2} \dfrac{30\sqrt{2}\sin\alpha - 26}{14}\, d\alpha = \boxed{0'44A}$

D) $C = I_{Lq} \cdot t_c \Rightarrow t_c = \dfrac{C}{I_{Lq}} = \dfrac{10Ah}{0'44A} = 22'72h$

C) $V_{R1q} = V_{R2q} = R_1 I_{Lq} = R_2 I_{Lq} = 6 \cdot 0'44 = 2'64\,V$

A) $I_{Dq} = \dfrac{I_{Lq}}{2} = \dfrac{0'44A}{2} = 0'22A$

$PIV = 30\sqrt{2} = 42'4V$

$I_{Dc} = I_c = \dfrac{30\sqrt{2} - 26}{14} = 1'17A$

B) $\eta = \dfrac{P_{bal}}{P_E / P_S} = \dfrac{\text{baliagarria}}{\text{totala}} = \dfrac{E \cdot I_{Lq}}{E \cdot I_{Lq} + 4V_F I_{Dq} + (R_1 + R_2 + 4r_F) I_{Dq}^2} = \dfrac{E \cdot I_{Lq}}{E \cdot I_{Lq} + 2V_F I_{Lq} + (R_1 + R_2 + 2r_F) I_{Lc}^2}$

$\Downarrow$

$0'36 \Rightarrow \%36$

$F = 2'57 = \dfrac{I_{Lc}}{I_{Lq}} \Rightarrow I_{Lc} = 2'57 \cdot 0'44 = 1'13A$

Uhin osoko artezgailua eta kondentsadoreko iragazkia erabiliz, elikatze iturri bat diseinatu.

Datuak kargan: $V_{Lq} = 150V$ $I_{Lq} = 20mA$ $r = \%1$

1) Kondentsadorearen kapazitatea.

2) Transformadorearen sekundarioaren tentsioa eta bere transformazio erlazioa.

3) Diodoek jasan behar duten gailur korrontea eta PIV tentsioa.